

CLIMATOLOGY OF WATER VAPOR IN THE UPPER TROPOSPHERE AND LOWER STRATOSPHERE DETERMINED FROM SAGE II OBSERVATIONS

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M.P. McCormick
NASA Langley Research Center
Hampton, VA 23681-0001

Er-Woon Chiou
Science Applications International Corp. (SAIC)
Hampton, VA 23666

1. INTRODUCTION

Water vapor in the upper troposphere and stratosphere, though much less abundant than near the earth's surface, plays a major role in the chemistry and physics of the atmosphere. For example, the results of recent studies (Peng et al., 1987; Arking, 1990) indicate that climate is just as sensitive to percentage changes in upper tropospheric water vapor, where the mixing ratio is very small, as it is to percentage changes in the planetary boundary layer. Unfortunately, earlier compilations of climatological water vapor distributions (such as Oort, 1983; Newell et al., 1973), which were based largely on radiosonde measurements over land, provide very limited information on the water vapor distributions for levels above 300mb and in many cases for lower levels also.

Current airborne and balloon-borne instruments (such as Lyman-alpha and Frost point hygrometers) capable of measuring water vapor in the upper troposphere and stratosphere are too expensive for routine use. Satellite-borne sensors, therefore, provide an excellent opportunity to obtain a unique set of measurements for this altitude region. The Limb Infrared Monitor of the Stratosphere (LIMS) instrument on Nimbus-7 (Russell, 1984) has illustrated the advantages of global remote sensing of stratospheric water vapor. The LIMS data set, although nearly global, is only for the 7-month period (November 1978 to May 1979) and, therefore, no seasonal or multiyear climatology could be developed. The Stratospheric Aerosol and Gas Experiment II (SAGE II) aboard the Earth Radiation Budget Satellite (ERBS), however, has been determining water vapor profiles in the stratosphere and troposphere all the way down to cloud tops since its launch in October

1984 (Rind et al., 1993; McCormick et al., 1993; Chu et al., 1993). Six papers on SAGE II water vapor validation were just published in the March 1993 issue of JGR. The applications of the SAGE II water vapor data have been published in a number of recent articles. For example, it was demonstrated by Rind et al (1991) that SAGE II observations have led to the confirmation of positive water vapor feedback in climate models, extremely important to understanding greenhouse warming. Other examples of the application of these data include the use of SAGE II water vapor profiles measured over Antarctic during October 1987 in a sensitivity analysis of the differential absorption lidar (DIAL) technique (Ismail et al., 1991). A SAGE II-derived water vapor climatology has been used in a photochemical model for the studies of stratospheric species (Callis et al., 1991).

The purpose of this paper is to present a vertically-resolved global climatology of water vapor in the upper troposphere and lower stratosphere based on multi-year SAGE II observations. Seasonally averaged zonal mean profiles are illustrated in terms of both mixing ratio and relative humidity.

2. SAGE II WATER VAPOR MEASUREMENTS

The SAGE II water vapor data set has several unique advantages: (1) a solar occultation technique is used which has the inherent capability of self-calibration, high accuracy and high vertical resolution; (2) measurements are made down to cloud tops, covering not only the stratosphere but also the upper- and middle-troposphere; and (3) the archived

data are near global and cover a four-year period (1986-89). Sensitivity analyses for the SAGE II water vapor retrieval (Chu et al., 1993) revealed that the SAGE II data are characterized by: (1) a random error of 18% for single profiles which is reduced when profiles are averaged (i.e. for the zonal mean); and (2) systematic errors are estimated to be about 20% from 10km to 40km for periods of low-to-moderate aerosol loading.

3. RESULTS AND DISCUSSIONS

In order to obtain the vertical distributions of water vapor in a climatological manner, we have used the 4-year (1986-89) archived SAGE II water vapor data set to derive the seasonally averaged mixing ratio profiles for each of the eight 20-degree latitudinal bands between 80S and 80N.

As pointed out by Yang et al.(1987), using averaged data in converting mixing ratio to relative humidity always has the potential to increase uncertainty because saturation vapor pressure is very non-linear with temperature. Since SAGE II archived water vapor data includes the pressure and temperature at 1km intervals for each water vapor profile, the information allows us to compute the relative humidity profile for each individual event before carrying out the seasonal zonal average. Thus, more accurate and more representative results for seasonal zonal mean relative humidity are obtained.

The listing of zonally averaged water vapor mixing ratio (in ppmv) for different seasons are given in Tables 1(a), 1(b), 1(c), and 1(d). The corresponding listings for relative humidity (in percentage) are given in Tables 2(a), 2(b), 2(c), and 2(d), respectively. Relative humidities are omitted for the region above 16.5km because the values are very small and not commonly used.

The zonally averaged mixing ratio profiles for DJF and JJA in each hemisphere are depicted in Figures 1(a) and 1(b), and Figures 2(a) and 2(b), respectively. The crosses in these figures denote the values at the average tropopause altitude.

Comparison of the two pairs of figures [1(a) and 2(b) - summer, 1(b) and 2(a) - winter] indicates that for the same season (local summer and local winter), the averaged profiles exhibit similar patterns in both hemispheres. A number of interesting features emerge upon further investigation of these figures: (1) The existence of a region of minimum water vapor mixing ratio (the hygropause) has been found in all latitude bands; (2) the distances between tropopause and hygropause altitudes vary between 1km to 4km, being greater at higher lati-

tudes; (3) most defined hygropauses appear at low latitudes (0-20S and 0-20N); (4) the smallest water vapor mixing ratios at lower latitudes appear in December-January-February for both hemispheres; and (5) for all latitude bands, there is a consistent positive poleward gradient of water vapor mixing ratio throughout the lower and middle stratosphere.

The profiles of zonally averaged relative humidity for DJF and JJA are depicted in figures 3(a) and 3(b), and 4(a) and 4(b) respectively. These results represent an extension of previous studies based on preliminary SAGE II observations (Chiou et al.,1992).

Due to the lack of relative humidity above 300mb, Yang et al.(1987) in their study of outgoing longwave radiation used the interpolation methods developed by Briegleb and Ramanathan (1982) and the formula derived by Harries (1976) to estimate the relative humidity at these pressure levels. The SAGE II-derived climatology of relative humidity presented herein can be used to avoid these empirical interpolation schemes. The vertical structure of relative humidity, which was derived from averaged mixing ratio and averaged temperature, presented in a recent study by Sun et al. (1993), could also be replaced by the more accurate climatology presented herein.

4. CONCLUDING REMARKS

In this paper, a climatology of water vapor in the upper troposphere and lower stratosphere is developed using the multi-year (1986-89) SAGE II observations. Zonally-averaged profiles of mixing ratio and relative humidity for the tropics and the mid- and high- latitudes are obtained for both hemispheres. The results are presented in graphical and tabulated form for various seasons.

It should be noted that the climatology presented is global for both stratosphere and troposphere but the tropospheric climatology represents clear-sky condition only because occultation data are taken from cloud tops and above. The information will be very useful for studies of stratospheric circulations, radiative budget of the stratosphere, and the atmospheric effects of stratospheric aircrafts. The inability of current GCMs to properly simulate many of the important details of moist processes are associated with our inadequate knowledge of atmospheric moisture content, especially at middle and upper tropospheric levels (Starr et al., 1990). Further, the existing upper tropospheric climatology is wetter than it should be due to in-situ instrument response times. Thus, the archived SAGE II water vapor

data set should be more widely exploited to increase our understanding of atmospheric chemistry, dynamics, climate effects, and the global water cycle.

5. REFERENCES

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Table 1(a) Zonally averaged H2O mixing ratio (ppmv) for DJF

	80S -60S	60S -40S	40S -20S	20S -0	0 -20N	20N -40N	40N -60N	60N -80N
6.5KM	186.00	349.00	619.00	807.00	738.00	375.00	138.00	.00
7.5KM	110.00	217.00	448.00	602.00	437.00	248.00	76.80	.00
8.5KM	52.50	120.00	289.00	397.00	270.00	144.00	42.10	.00
9.5KM	21.90	61.50	161.00	230.00	172.00	82.60	23.50	.00
10.5KM	7.68	27.70	88.90	129.00	102.00	44.00	11.80	.00
11.5KM	3.65	11.80	43.70	59.40	48.90	20.60	5.88	.00
12.5KM	2.99	6.14	22.00	31.90	24.90	10.10	3.99	.00
13.5KM	2.96	3.88	10.80	16.00	12.70	5.37	3.32	.00
14.5KM	3.06	3.09	5.61	8.20	6.61	3.36	3.17	.00
15.5KM	3.44	3.21	3.62	4.50	3.60	2.87	3.50	.00
16.5KM	3.79	3.49	3.10	2.82	2.47	2.92	3.81	.00
17.5KM	4.14	3.71	3.19	2.47	2.18	3.21	4.00	.00
18.5KM	4.53	3.95	3.59	2.97	2.80	3.70	4.17	.00
19.5KM	4.79	4.19	3.77	3.20	3.12	3.94	4.37	.00
20.5KM	5.01	4.44	3.99	3.51	3.50	4.20	4.57	.00
21.5KM	5.18	4.69	4.22	3.74	3.74	4.46	4.77	.00
22.5KM	5.28	4.90	4.45	3.88	3.93	4.69	4.95	.00
23.5KM	5.34	5.07	4.68	4.02	4.16	4.90	5.10	.00
24.5KM	5.38	5.20	4.89	4.19	4.37	5.05	5.22	.00
25.5KM	5.41	5.28	5.05	4.35	4.54	5.15	5.30	.00
26.5KM	5.44	5.33	5.16	4.51	4.69	5.20	5.35	.00
27.5KM	5.47	5.36	5.24	4.65	4.78	5.23	5.41	.00
28.5KM	5.52	5.39	5.28	4.74	4.82	5.25	5.46	.00
29.5KM	5.57	5.43	5.30	4.82	4.84	5.27	5.52	.00
30.5KM	5.62	5.47	5.32	4.87	4.87	5.30	5.59	.00
31.5KM	5.69	5.53	5.34	4.90	4.89	5.36	5.69	.00
32.5KM	5.75	5.58	5.36	4.90	4.93	5.43	5.78	.00
33.5KM	5.83	5.65	5.39	4.89	4.98	5.52	5.88	.00
34.5KM	5.91	5.71	5.43	4.89	5.03	5.62	5.98	.00
35.5KM	5.99	5.77	5.49	4.91	5.08	5.72	6.07	.00
36.5KM	6.08	5.83	5.54	4.95	5.12	5.81	6.15	.00
37.5KM	6.18	5.90	5.59	5.00	5.15	5.88	6.22	.00
38.5KM	6.28	5.96	5.66	5.05	5.19	5.94	6.27	.00
39.5KM	6.38	6.03	5.73	5.10	5.24	5.99	6.31	.00
40.5KM	6.47	6.10	5.80	5.16	5.30	6.05	6.37	.00

Table 1(b) Zonally averaged H2O mixing ratio (ppmv) for MAM

	80S -60S	60S -40S	40S -20S	20S -0	0 -20N	20N -40N	40N -60N	60N -80N
6.5KM	156.00	243.00	479.00	753.00	1090.00	477.00	150.00	103.00
7.5KM	88.50	143.00	323.00	437.00	736.00	318.00	88.30	57.60
8.5KM	43.50	80.70	198.00	267.00	411.00	186.00	50.80	32.70
9.5KM	18.80	44.40	116.00	166.00	242.00	105.00	27.60	17.50
10.5KM	7.00	22.00	62.80	100.00	138.00	55.50	12.50	7.36
11.5KM	3.42	9.99	30.70	51.90	66.20	25.20	5.82	3.72
12.5KM	2.84	5.15	15.30	28.30	33.50	12.20	3.70	3.11
13.5KM	2.79	3.34	7.50	14.70	15.60	6.52	3.02	3.09
14.5KM	2.89	2.85	4.23	7.72	7.61	3.86	2.86	3.23
15.5KM	3.31	3.06	3.16	4.18	4.13	3.08	3.27	3.76
16.5KM	3.70	3.37	2.91	2.67	2.67	2.97	3.70	4.19
17.5KM	4.03	3.64	3.02	2.40	2.34	3.16	4.03	4.48
18.5KM	4.36	3.93	3.43	2.78	2.66	3.62	4.33	4.74
19.5KM	4.59	4.14	3.69	3.02	2.94	3.94	4.53	4.91
20.5KM	4.81	4.36	3.96	3.42	3.38	4.26	4.73	5.06
21.5KM	4.99	4.58	4.20	3.72	3.71	4.54	4.92	5.18
22.5KM	5.13	4.80	4.42	3.90	3.91	4.77	5.07	5.27
23.5KM	5.22	4.99	4.63	3.99	4.05	4.94	5.20	5.34
24.5KM	5.30	5.16	4.81	4.06	4.14	5.07	5.31	5.40
25.5KM	5.36	5.30	4.96	4.20	4.25	5.17	5.41	5.45
26.5KM	5.42	5.42	5.08	4.39	4.39	5.23	5.49	5.51
27.5KM	5.49	5.51	5.18	4.49	4.50	5.29	5.56	5.57
28.5KM	5.57	5.59	5.24	4.59	4.56	5.33	5.64	5.63
29.5KM	5.65	5.66	5.27	4.68	4.63	5.36	5.71	5.69
30.5KM	5.72	5.72	5.28	4.76	4.70	5.38	5.77	5.75
31.5KM	5.80	5.78	5.28	4.82	4.76	5.40	5.84	5.82
32.5KM	5.89	5.84	5.29	4.87	4.81	5.43	5.91	5.90
33.5KM	5.99	5.89	5.31	4.93	4.90	5.47	5.96	5.97
34.5KM	6.08	5.93	5.35	5.01	5.01	5.53	6.00	6.01
35.5KM	6.17	5.98	5.39	5.10	5.14	5.59	6.02	6.04
36.5KM	6.26	6.04	5.43	5.20	5.26	5.65	6.03	6.06
37.5KM	6.35	6.10	5.48	5.28	5.33	5.67	6.04	6.08
38.5KM	6.43	6.17	5.54	5.37	5.40	5.69	6.06	6.10
39.5KM	6.51	6.25	5.61	5.45	5.46	5.72	6.09	6.14
40.5KM	6.59	6.35	5.69	5.55	5.53	5.76	6.14	6.20

Table 1(c) Zonally averaged H2O mixing ratio (ppmv) for JJA

	80S -60S	60S -40S	40S -20S	20S -0	0 -20N	20N -40N	40N -60N	60N -80N
6.5KM	.00	155.00	316.00	420.00	979.00	694.00	624.00	399.00
7.5KM	.00	86.20	205.00	300.00	659.00	520.00	374.00	233.00
8.5KM	.00	46.10	130.00	202.00	425.00	309.00	224.00	135.00
9.5KM	.00	25.00	77.40	146.00	266.00	185.00	127.00	67.80
10.5KM	.00	12.50	44.30	93.50	150.00	109.00	62.80	27.00
11.5KM	.00	6.05	22.10	50.40	71.40	54.40	26.00	9.71
12.5KM	.00	3.74	11.90	28.10	34.80	29.00	11.00	4.56
13.5KM	.00	2.99	6.71	15.50	17.20	15.20	5.53	3.30
14.5KM	.00	2.80	4.37	8.77	9.49	8.41	3.75	3.00
15.5KM	.00	3.10	3.53	5.49	5.92	5.42	3.39	3.19
16.5KM	.00	3.43	3.24	3.87	4.13	4.10	3.40	3.51
17.5KM	.00	3.68	3.25	3.16	3.43	3.66	3.53	3.87
18.5KM	.00	3.93	3.58	3.08	3.24	3.65	3.83	4.29
19.5KM	.00	4.08	3.82	3.36	3.41	3.79	4.06	4.53
20.5KM	.00	4.24	4.07	3.49	3.53	4.00	4.30	4.77
21.5KM	.00	4.41	4.28	3.68	3.67	4.23	4.54	4.97
22.5KM	.00	4.58	4.46	3.84	3.87	4.42	4.76	5.13
23.5KM	.00	4.76	4.62	4.05	4.07	4.60	4.96	5.25
24.5KM	.00	4.92	4.76	4.25	4.20	4.76	5.13	5.34
25.5KM	.00	5.06	4.86	4.35	4.28	4.89	5.27	5.44
26.5KM	.00	5.17	4.92	4.45	4.39	5.00	5.37	5.52
27.5KM	.00	5.26	4.96	4.52	4.49	5.08	5.45	5.61
28.5KM	.00	5.34	4.98	4.60	4.58	5.13	5.53	5.71
29.5KM	.00	5.40	5.00	4.68	4.66	5.17	5.61	5.81
30.5KM	.00	5.47	5.03	4.77	4.70	5.20	5.68	5.90
31.5KM	.00	5.55	5.08	4.87	4.74	5.23	5.75	5.97
32.5KM	.00	5.62	5.16	4.99	4.78	5.28	5.83	6.05
33.5KM	.00	5.69	5.27	5.13	4.85	5.34	5.93	6.13
34.5KM	.00	5.75	5.40	5.30	4.95	5.41	6.02	6.21
35.5KM	.00	5.81	5.55	5.46	5.05	5.48	6.10	6.28
36.5KM	.00	5.88	5.71	5.59	5.13	5.56	6.16	6.34
37.5KM	.00	5.94	5.85	5.70	5.19	5.62	6.20	6.38
38.5KM	.00	6.00	5.97	5.77	5.24	5.66	6.25	6.42
39.5KM	.00	6.09	6.07	5.83	5.29	5.70	6.30	6.46
40.5KM	.00	6.19	6.18	5.88	5.34	5.74	6.36	6.52

Table 1(d) Zonally averaged H2O mixing ratio (ppmv) for SON

	80S -60S	60S -40S	40S -20S	20S -0	0 -20N	20N -40N	40N -60N	60N -80N
6.5KM	53.70	143.00	453.00	491.00	1140.00	597.00	266.00	362.00
7.5KM	29.50	79.80	330.00	310.00	654.00	415.00	163.00	198.00
8.5KM	16.10	44.50	218.00	231.00	383.00	247.00	91.80	107.00
9.5KM	9.89	24.80	128.00	159.00	239.00	139.00	50.10	55.40
10.5KM	4.75	12.20	67.50	102.00	160.00	75.00	25.00	23.90
11.5KM	2.78	5.92	30.80	54.00	78.00	36.00	12.10	9.98
12.5KM	2.37	3.88	14.10	29.20	37.30	18.60	6.88	5.00
13.5KM	2.30	3.27	7.49	15.30	18.10	9.97	4.69	3.69
14.5KM	2.39	3.11	4.83	8.23	9.12	5.90	3.89	3.27
15.5KM	2.81	3.37	4.05	5.11	5.03	4.48	3.81	3.28
16.5KM	3.24	3.63	3.84	3.77	3.67	4.01	3.80	3.43
17.5KM	3.63	3.84	3.79	3.45	3.49	3.92	3.81	3.68
18.5KM	4.08	4.09	3.82	3.47	3.64	3.88	3.94	4.03
19.5KM	4.49	4.29	3.96	3.50	3.58	3.95	4.13	4.26
20.5KM	4.90	4.49	4.12	3.54	3.58	4.10	4.34	4.49
21.5KM	5.28	4.69	4.29	3.66	3.67	4.27	4.56	4.71
22.5KM	5.57	4.88	4.45	3.88	3.85	4.46	4.77	4.90
23.5KM	5.76	5.04	4.60	4.08	4.07	4.64	4.96	5.05
24.5KM	5.85	5.17	4.73	4.20	4.23	4.81	5.13	5.18
25.5KM	5.87	5.26	4.84	4.30	4.39	4.94	5.26	5.30
26.5KM	5.86	5.31	4.91	4.42	4.54	5.05	5.36	5.40
27.5KM	5.84	5.35	4.97	4.48	4.64	5.13	5.44	5.50
28.5KM	5.84	5.38	5.02	4.53	4.70	5.17	5.51	5.61
29.5KM	5.85	5.41	5.07	4.58	4.74	5.19	5.56	5.71
30.5KM	5.87	5.47	5.13	4.64	4.76	5.19	5.61	5.80
31.5KM	5.91	5.54	5.19	4.70	4.78	5.20	5.66	5.86
32.5KM	5.95	5.62	5.28	4.80	4.82	5.22	5.72	5.94
33.5KM	6.00	5.72	5.38	4.91	4.89	5.26	5.79	6.01
34.5KM	6.05	5.82	5.49	5.05	5.00	5.31	5.86	6.09
35.5KM	6.09	5.91	5.60	5.20	5.11	5.38	5.93	6.15
36.5KM	6.13	5.99	5.71	5.34	5.23	5.45	6.02	6.20
37.5KM	6.17	6.05	5.81	5.46	5.33	5.53	6.10	6.27
38.5KM	6.20	6.10	5.91	5.57	5.43	5.62	6.18	6.34
39.5KM	6.25	6.15	6.00	5.68	5.52	5.71	6.26	6.41
40.5KM	6.29	6.21	6.08	5.77	5.61	5.81	6.35	6.50

Table 2(a) Zonally averaged relative humidity (%) for DJF

	80S	60S	40S	20S	0	20N	40N	60N
	-60S	-40S	-20S	-0	-20N	-40N	-60N	-80N
6.5KM	58.900	37.500	15.900	15.800	14.400	18.500	32.600	.000
7.5KM	48.600	37.500	19.200	18.400	13.600	20.700	30.100	.000
8.5KM	33.100	31.600	22.100	20.400	14.600	20.700	28.400	.000
9.5KM	14.300	23.600	23.200	22.000	16.800	21.000	23.000	.000
10.5KM	4.430	14.800	24.100	24.400	18.800	19.200	14.100	.000
11.5KM	1.670	7.510	21.000	22.600	18.000	13.700	7.150	.000
12.5KM	.990	4.250	18.500	25.100	19.100	9.980	4.100	.000
13.5KM	.748	2.570	14.700	25.000	19.900	7.510	2.810	.000
14.5KM	.617	1.750	11.700	24.400	20.100	6.210	2.420	.000
15.5KM	.558	1.570	8.860	19.200	16.100	5.970	2.450	.000
16.5KM	.488	1.540	9.140	17.700	16.600	7.070	2.490	.000

Table 2(b) Zonally averaged relative humidity (%) for MAM

	80S	60S	40S	20S	0	20N	40N	60N
	-60S	-40S	-20S	-0	-20N	-40N	-60N	-80N
6.5KM	47.500	31.700	17.500	13.700	20.800	17.800	33.200	43.100
7.5KM	37.400	31.900	20.200	12.000	22.400	19.900	30.400	33.400
8.5KM	25.500	29.800	22.000	12.600	21.300	21.600	28.900	27.600
9.5KM	11.300	25.400	23.600	14.200	22.800	23.100	22.500	17.500
10.5KM	3.720	17.800	23.300	16.700	24.900	22.300	12.200	7.160
11.5KM	1.480	9.390	18.300	17.500	24.700	16.600	5.850	3.020
12.5KM	.957	4.790	14.200	19.900	26.700	12.400	3.250	1.920
13.5KM	.766	2.830	10.200	21.000	25.000	9.250	2.180	1.550
14.5KM	.675	2.140	7.870	22.000	23.300	7.100	1.810	1.370
15.5KM	.661	2.050	6.500	16.900	17.500	6.170	1.810	1.390
16.5KM	.635	2.010	6.700	16.100	16.000	6.620	1.830	1.360

Table 2(c) Zonally averaged relative humidity (%) for JJA

	80S	60S	40S	20S	0	20N	40N	60N
	-60S	-40S	-20S	-0	-20N	-40N	-60N	-80N
6.5KM	.000	29.800	16.600	7.810	17.200	14.800	28.300	42.300
7.5KM	.000	29.400	17.700	8.630	18.300	17.800	29.300	43.600
8.5KM	.000	26.700	18.300	10.100	19.700	18.200	31.000	42.700
9.5KM	.000	23.000	18.700	13.500	22.500	19.900	31.400	32.100
10.5KM	.000	14.900	17.300	16.600	25.200	21.800	25.900	16.900
11.5KM	.000	7.380	12.600	18.300	25.100	20.400	14.300	5.480
12.5KM	.000	4.430	10.300	21.600	27.100	19.800	7.470	2.020
13.5KM	.000	3.440	8.350	23.300	25.800	17.200	3.960	1.100
14.5KM	.000	2.790	6.950	24.200	26.200	15.200	2.580	.788
15.5KM	.000	2.700	5.970	20.200	21.500	11.800	2.010	.687
16.5KM	.000	2.670	5.950	19.200	20.000	11.900	1.830	.637

Table 2(d) Zonally averaged relative humidity (%) for SON

	80S	60S	40S	20S	0	20N	40N	60N
	-60S	-40S	-20S	-0	-20N	-40N	-60N	-80N
6.5KM	30.500	27.300	18.600	9.580	21.100	18.500	30.300	44.600
7.5KM	27.600	25.200	22.200	9.360	18.200	21.200	33.200	42.200
8.5KM	26.300	23.100	24.600	12.100	18.200	22.700	32.500	39.800
9.5KM	26.700	19.800	26.000	15.300	20.700	23.500	28.600	31.600
10.5KM	16.300	12.300	23.500	18.700	26.800	23.500	20.800	18.700
11.5KM	10.000	6.580	16.700	20.100	27.700	20.000	11.800	7.280
12.5KM	8.230	4.300	12.000	22.900	29.300	17.900	6.840	2.940
13.5KM	7.290	3.430	9.190	24.300	30.100	15.000	4.230	1.680
14.5KM	7.170	3.010	7.730	24.900	30.300	12.600	3.170	1.200
15.5KM	7.410	2.990	6.820	19.900	22.200	10.600	2.770	.981
16.5KM	7.040	2.810	7.130	19.500	21.200	10.900	2.480	.857



